Space Weather Technical Forecast

Issued on Wednesday, 24 July 2024 at 13:13 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: G1-G2/Minor-Moderate likely with a reducing chance of a G3/Strong Geomagnetic Storm 24 Jul. Chance of R1 Radio Blackouts throughout.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Activity has remained Moderate, with a peak M3.6 flare at 24/0742UTC from AR3751 in the southwest. There are currently nine sunspot regions on the visible disc. The two prominent spots in the southwest have shown little change. AR3751 exhibits minor proliferation of trailing spots, and nearby AR3761 to the east, has seen a slight overall reduction in size and clarity of penumbra. AR3762 in the southeast has shown some development within its intermediate portion, which may tenuously contain a weak delta spot. This region does have a complex trailing spot which also consists of a more clearly defined delta spot. There are three spots in the far east of the disc, all of which appear simple at present even given the flaring from near AR3764 just south of the equator on 23 Jul. All other remaining regions are small or simple.

There were three CMEs observed in coronagraph imagery in the past 24 hours. The first was a full halo CME from the far-side of the Sun around 23/0030UTC, which produced a minor (S1) proton storm event, which has now ended. The second was observed at 23/0400UTC off the southwest limb, associated with a C3 flare, which has been analysed as a likely miss ahead of Earth arriving at 1AU on 26 Jul. The final CME was from the southeast limb, associated with the M2.4 flare near AR3764 at 23/1430UTC. This gave a wide and moderately fast CME, perhaps with low confidence of glancing impacts at Earth possible either late on 26 Jul or early on the 27 Jul.

Solar Wind / Geomagnetic Activity: The solar wind, as measured by ACE at L1, was at mostly background conditions until a weak CME (thought to be from 19 Jul) arrived around 23/1950UTC. Speeds remained slow throughout, but jumped from 250 km/s to a peak of around 340 km/s. Density was mostly weak but became moderate from 23/1950UTC peaking at around 10ppcc. The interplanetary magnetic field (IMF), Bt, was weak, becoming Moderate to Strong after 23/1950UTC, with a peak of 19nT. The important north-south component, Bz, was almost entirely positive (northward), especially after 23/1950UTC where it peaked at +12nT. The phi angle was mostly away from the Sun (positive), but became negative (Towards the Sun) after 23/2120UTC. The net result of the above solar wind measures was for mostly Quiet (Kp 1-2) geomagnetic indices, with an Unsettled (Kp3) interval observed 23/1800-2100UTC.

Energetic Particles / Solar Radiation: High energy (greater than 10 MeV) proton flux observed by GOES18 showed a rapid rise in proton levels from early on the 23 Jul, due to a large full halo CME from the far-side of the Sun, which resulted in both the 10MeV and 100MeV threshold being reached. This event has now ended, with both the 10MeV and 100MeV returning to background levels. High energy electron flux (greater than 2MeV) observed at GOES16 was at Normal Background. The 24-hour fluence was well below Active, with 1.25e6 integrated pfu observed at 24/0000UTC.

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Met Office Space Weather Technical Forecast

Four-Day Space Weather Forecast Summary

Solar Activity: Moderate activity is Likely throughout, with further M-class flares likely notably from AR3762 and AR3751, which are the most complex regions on the disc at present.

Solar Wind /Geomagnetic Activity: No coronal holes or their fast winds feature in the forecast period. Earth is currently experiencing a rather slow and weak CME. Two further CMEs are expected in the period. The first and most notable, is expected to arrive at Earth during day 1 (24 July), although timing of arrival is a little uncertain. Speeds may reach enhanced or strong, around 500-700 km/s during the event. The second was a wide a moderately fast CME, with low confidence of glancing impacts at Earth on either late on day 3 (26 Jul) or early day 4 (27 Jul).

Geomagnetic activity will likely become enhanced day 1 (24 Jul) with G1-G2/Minor-Moderate storms likely and a low confidence chance of G3/Strong storms. Geomagnetic activity should begin to wane into day 2 (25 Jul), with Quiet conditions likely. There is a slight chance of G1 Minor Storms should the CME from 23 Jul arrive late day 3 (26 Jul) or early day 4 (27 Jul).

Energetic Particles / Solar Radiation: High energy proton flux has returned to background levels, after the recent S1 proton storm event. Slight Chance of rising above the S1/Minor Storm threshold in response to any notable flares throughout the period.

High energy electron flux is expected to remain at Normal Background levels initially, however confidence decreases due to given inbound CMEs. There is a possible rising Slight Chance of Active later in the period once geomagnetic activity wanes.

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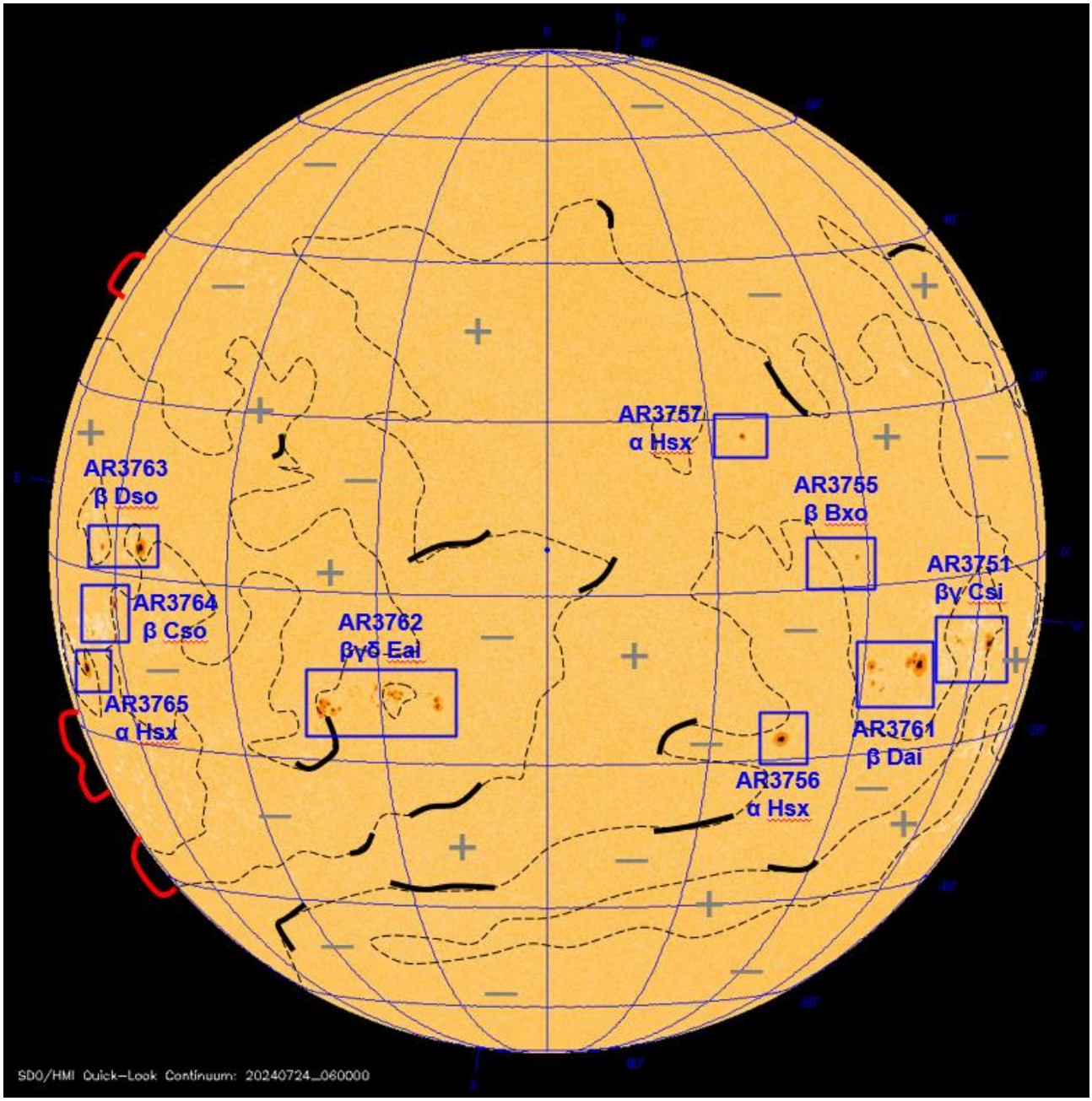
Figure 1. Solar Analysis Valid 24/0600 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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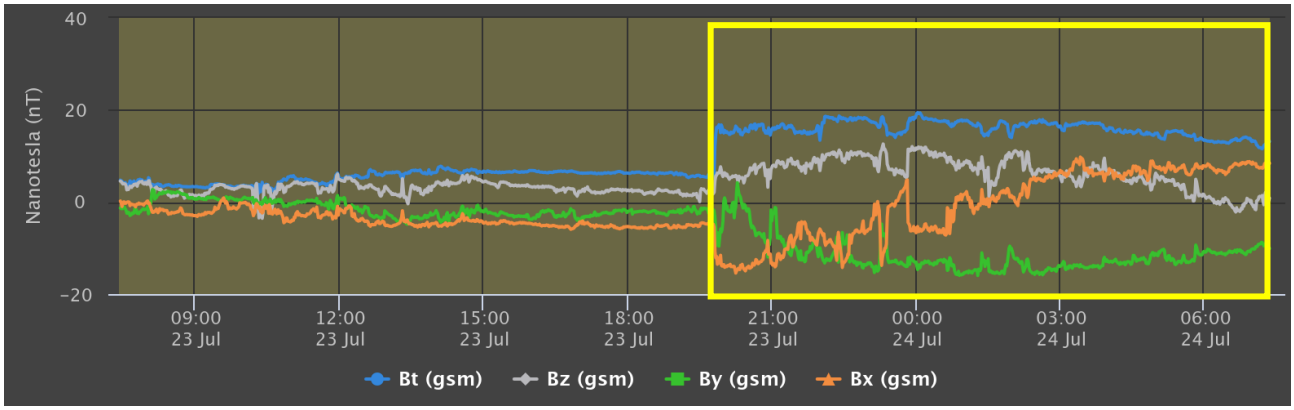
Geomagnetic Storms:

No coronal holes or their fast winds feature in the forecast period. Earth is currently experiencing a rather slow and weak CME, believed to be that from 19 July. There are up to two further CMEs expected in the period.

Figure 2: L1 Magnetometer shows a weak CME (yellow box) arrived at Earth around 23/1950 UTC – thought to be associated with the CME which left the Sun on the 19 July. North-South component, Bz, was predominately positive (northward).



The first, and most notable CME, was from a filament lift-off was observed at 21/1630 UTC. The ejecta was soon followed by a full halo CME on coronagraph imagery. This is still expected to arrive at Earth during day 1 (24 July), although arrival time is a little uncertain, even at this stage. Speeds may reach enhanced or strong, around 500-700 km/s during this event, depending on when the CME arrives. The later the CME arrives, then any impacts are likely to be weaker than anticipated.

The second CME was from a long period M2.4 flare close to the southeast limb near AR3764 at 23/1430 UTC. This gave a wide and moderately fast CME, perhaps with low confidence of glancing impacts at Earth possible either late on 26 Jul or early 27 Jul (days 3 and 4).

Geomagnetic activity will likely become enhanced day 1 (24 Jul) with G1-G2/Minor-Moderate storms likely and a low confidence chance of a G3/Strong storm interval. Geomagnetic activity should begin to wane into day 2 (25 Jul), with Quiet conditions likely. There is a slight chance of G1 Minor Storms should the CME from 23 Jul arrive either late on day 3 (26 Jul) or early day 4 (27 Jul).

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	60	10	20	5
Strong	G3	No	30	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

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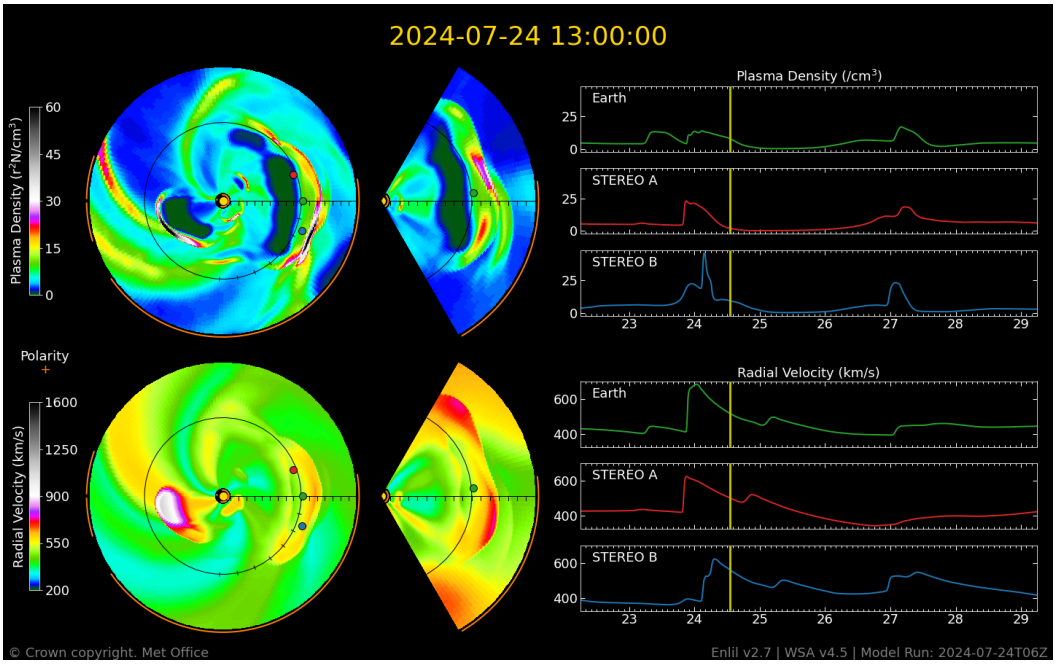
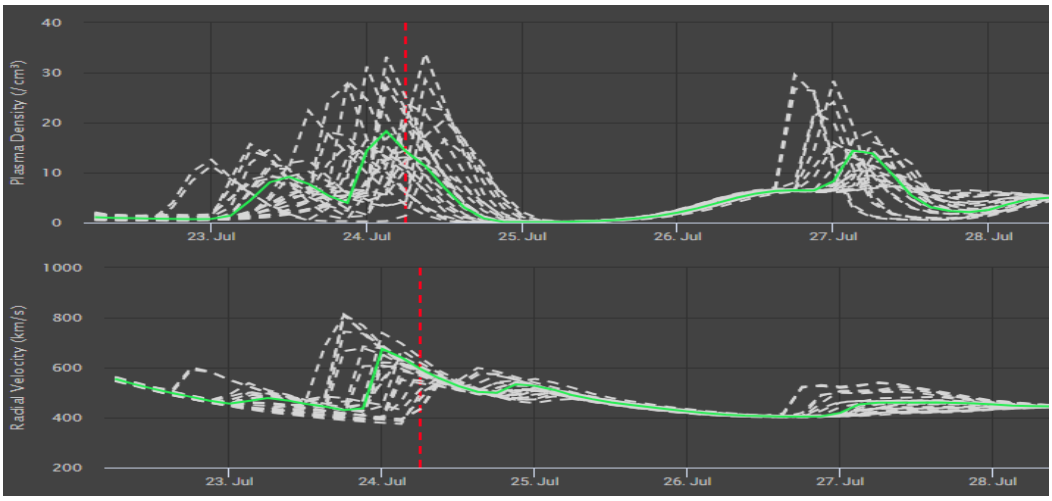
Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
21/1629	Full	Filament Eruption	NE	1050 km/s	24/0300 UTC +/- 9 hours	Likely
23/2224	Partial	M2.4	SE	560 km/s	26/1500 UTC +/1 12 hours	Low confidence due to location. Shock most probable.

Figure 3: MOSWOC Enlil and Ensemble shows the likely arrival of a CME today (24 Jul) and a possible glancing blow on 26-27 July.





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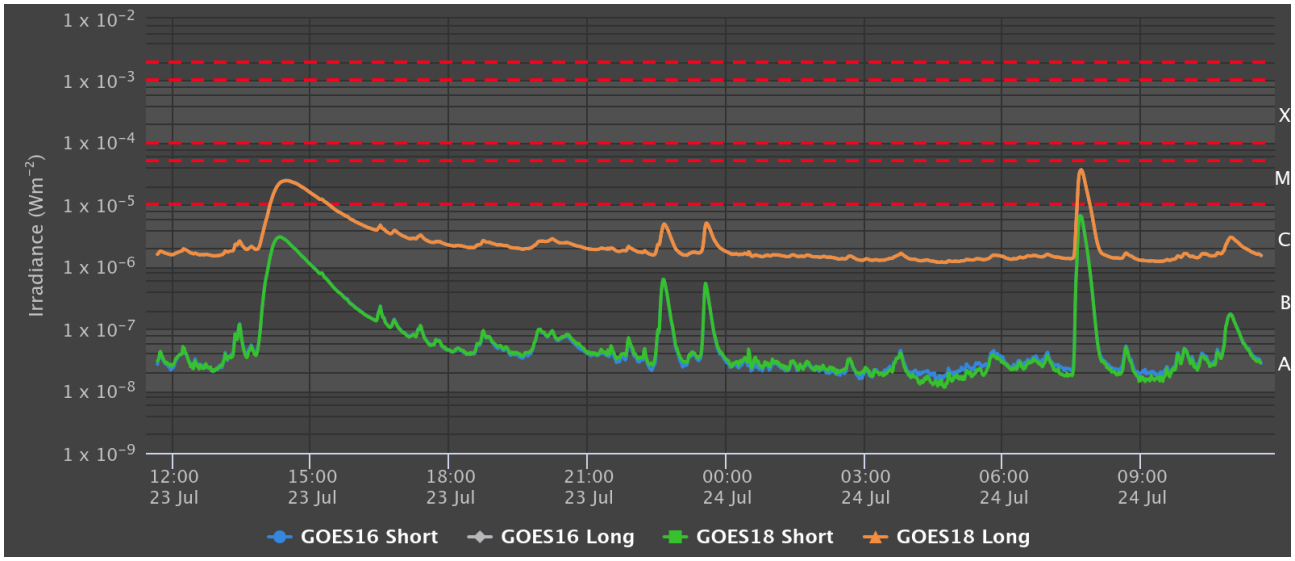
Radio Blackouts - X-Ray Flares:
Activity has remained Moderate, with a peak M3.6 flare at 24/0742UTC from AR3751 in the southwest. There are currently nine sunspot regions on the visible disc. The two prominent spots in the southwest have shown little change. AR3751 exhibits minor proliferation of trailing spots, and nearby AR3761 to the east, has seen a slight overall reduction in size and clarity of penumbra. AR3762 in the southeast has shown some development within its intermediate portion, which may tenuously contain a weak delta spot, which will continue to be monitored for any further development. This region already has a complex trailing spot consisting of a more clearly defined delta spot. There are three sunspots in the far east of the disc, all of which appear simple at present even given the flaring from near AR3764 just south of the equator on 23 Jul. All other remaining regions are small or simple.

Activity is expected to be Low to Moderate with a chance of further M-class flares. This risk likely remaining the same through the period due to a likely near equilibrium of off-going and oncoming spots from the visible disc.

X Ray Flares Probability	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	R1-R2 M Class	Yes	50	50	50	50
Very Active	R3 to R5 X Class	No	5	5	5	5

Figure 4: GOES-18 X Ray Flux trace.



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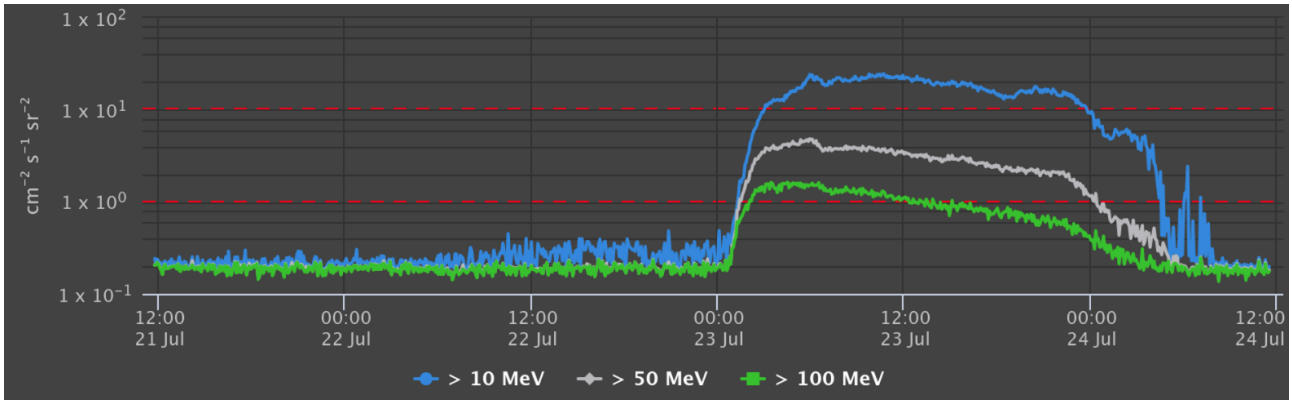
Solar Radiation Storms - (High Energy Protons):
GOES18 proton flux showed a rapid rise early on the 23 Jul with the 10MeV and 100MeV threshold being reached. This was in response to a very large full halo CME, which occurred on the far-side of the Sun. The S1 Minor storm has now ended, with proton levels returning to background levels. High energy proton levels are likely to remain at background levels, although there is a slight risk of reaching the S1 threshold if any notable flares occur throughout the remainder of the period.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	Yes	20	20	20	20
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

Figure 5: GOES-18 Proton Flux for the last 3 days – shows the recent S1 proton storm event due to a full halo CME on the far-side of the Sun early on 23 Jul. High energy protons levels have recently returned to background levels.



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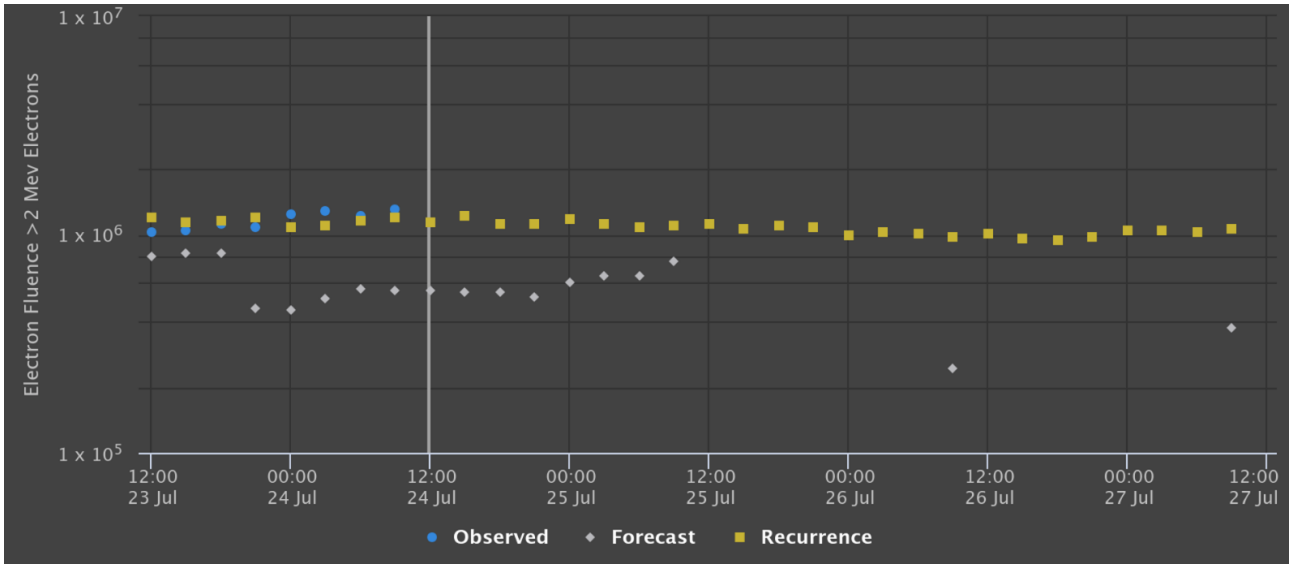
High Energy Electrons Event (≥ 2MeV):
The high energy electron flux as observed by GOES16 is currently at Normal Background and is expected to persist at this level initially. Persistence methods and MOSWOC REFM are not expected to offer a useful steer to eventual fluence levels in the period, owing to the dominance of CMEs in the forecast. On balance, confidence decreases sharply through the period, with a possible rising Slight Chance of Active later in the period once geomagnetic activity wanes.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	1	10	15	20
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

Figure 6: MOSWOC REFM electron fluence.



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